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Gastroschisis: factors influencing 3-year survival and digestive outcome

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Abstract

Background: Gastroschisis patients' morbidity is still high, underlining the importance of identifying factors associated with adverse outcomes.

Objective: To determine factors influencing gastroschisis patients' morbimortality during the first 3 years of life in Centro Hospitalar São João (CHSJ).

Methodology: Records of infants born with gastroschisis between January 2002 and December 2011 admitted to CHSJ were reviewed. The relation between demographic and clinical data and morbimortality during the first 3 years of life, specifically anthropometric evolution and digestive outcome, was evaluated. The factors that were compared were simple versus complex gastroschisis and primary versus secondary closure.

Results: Forty records were analysed. The survival rate was 92.3%. Patients with complex gastroschisis had worse outcomes: hospital stay (median 59 versus 23.5 days), total parenteral nutrition (50 versus 19 days), total oral intake reached (47 versus 22.5 days), morphine analgesia (9 versus 3 days), intestinal occlusion (60% versus 11.8%), perforation (60% versus 0%) and ischaemia (40% versus 0%), sepsis (100% versus 32.4%), short bowel syndrome (40% versus 3.1%), laxative need during 1-year follow-up (40% versus 0%), weight percentile <5 at 6 months (75% versus 13.6%) and gastrointestinal symptoms after the first year of life (OR: 42; 95% CI: 2.01-877.5). Secondary closure patients had worse outcomes: start of oral intake (25 versus 11.5 days), total oral intake reached (48 versus 23 days), necrotizing enterocolitis (40% versus 2.9%) and mortality (40% versus 2.9%).

Conclusion: Complex gastroschisis and secondary closure were both associated with higher morbidity. Secondary closure was also associated with higher mortality. Complex gastroschisis revealed to be a predictive factor for higher incidence of gastrointestinal symptoms after the first year of life. Therefore, follow-up at least until 3 years of life of patients with complex gastroschisis is recommended. Further research is needed to determine management strategies that improve prognosis.

Keywords: complex gastroschisis, abdominal wall defect, secondary closure, outcome, morbidity, follow-up.

1. Introduction

Gastroschisis is a congenital abdominal wall defect in which the abdominal viscera herniate through a para-umbilical defect, usually to the right of the umbilicus, without a covering membrane. It is a rare malformation but its incidence has been increasing worldwide, with the current rate being 4-5 cases per 10,000 live births.[1-4]

Due to the small number of cases and limited research opportunities, there is still discussion about the development of this malformation, hence there are several gastroschisis pathogenesis theories. To help better understand the causes for this multifactorial abnormality, research has pursued the identification of the risk factors, with the main one being young maternal age. Other usually considered risk factors are geographical region, low socioeconomic status, first pregnancy, previous terminations, poor maternal diet, vasoactive medication, smoking and recreational drugs, other environmental factors and gene polymorphisms.[1, 2, 4]

Association with other gastrointestinal anomalies has been described, most frequently with intestinal atresia, but also intestinal volvulus, perforation or necrosis. It can also be associated with anomalies of other systems, such as cryptorchidism.[1, 4, 5]

Prenatal diagnosis can be made starting from the end of the first trimester of pregnancy, usually by ultrasound. It allows for multidisciplinary counselling and planned delivery at a tertiary centre.[1, 4]

The initial management of patients with gastroschisis has improved over the years, through neonatal intensive care, parenteral nutrition and surgical techniques. This has contributed to a rise in survival rates to over 90%.[5-7] However, morbidity is still high, underlining the importance of identifying factors associated with adverse outcomes. A documented factor is the presence of intestinal complications (atresia, volvulus, perforation or necrosis), leading to the widespread use of the term complex gastroschisis to describe these situations. [8-10] Additional research is needed to identify outcome predictive factors in order to improve medical care for these patients.[11]

Objective: To determine factors influencing mortality and morbidity during the first 3 years of life of infants born with gastroschisis admitted to Centro Hospitalar São João (CHSJ).

2. Methodology

This is a retrospective study of all infants born with gastroschisis between January 2002 and December 2011 admitted to the Neonatal Intensive Care Unit (NICU) of CHSJ, a tertiary referral centre for paediatric and neonatal surgery cases in the north of Portugal. Data regarding demographic characteristics, neonatal and paediatric hospitalization, surgical treatment and follow-up during the first three years of life were obtained from the patients' medical records.

The relation between demographic and clinical data and the morbimortality during the first three years of life, specifically anthropometric evolution and digestive prognosis, was evaluated.

Data concerning partial Graffar classification, family history of malformations and consanguinity, mother's age, gravidity and previous abortions were collected. Data regarding pregnancy included twinning, surveillance, smoking, alcohol and recreational drugs consumption, medication, complications (oligohydramnios, intrauterine growth restriction, gastroschisis volvulus and other), diagnosis (if prenatal, gestational age). Gestational age at birth, place of birth, type of delivery, gender, reanimation, meconium aspiration, Apgar score at 1^{st} and 5^{th} minutes, weight, major malformations (gastrointestinal atresia, enteric duplication cyst, microcolon, intestinal volvulus, cardiac malformation, cryptorchidism), minor anomalies, chromosome anomalies, gastroschisis type (simple or complex), herniated organs, time to surgery, type of surgery, time with silo and other surgeries were also obtained. For the purpose of this study, major malformation was defined as an anomaly or malformation that

creates significant medical problems for the patient or that requires specific surgical or medical management.[12]

Morbidity indicators considered included information from the first hospitalization and follow-up. Duration of hospital stay, total parenteral nutrition (TPN) duration, start of oral intake, time to total oral intake, ventilation, analgesia and sedation, wound dehiscence, intestinal occlusion, bowel perforation, bowel ischaemia, necrotizing enterocolitis (NEC), sepsis, cholestasis, multiple organ failure, short bowel syndrome and discharge with parenteral nutrition were evaluated. The follow-up was divided into two periods, up to one year of life and between one and three years of life, and the variables considered were: surgeries for umbilical hernia, intestinal occlusion and intestinal lengthening, gastro-oesophageal reflux disease (GERD), intestinal subocclusion, co-morbidities, gastrointestinal symptoms (vomiting, diarrhoea, constipation), medication use (prokinetics, laxatives, antacids) and anthropometric evaluation (weight and length). The gastrointestinal symptoms were considered if present during at least three consecutive months.

Outcomes of patients born with simple gastroschisis were compared with those of patients born with complex gastroschisis (defined by the presence of intestinal atresia, necrosis or perforation at birth). Similarly, patients who underwent primary closure (single procedure to reduce the herniated organs and close the abdominal wall, which could include enterectomy) were compared with those who underwent secondary closure (placement of a silo, progressive reduction of the herniated organs and closure at a later date).

The statistical analysis was performed using SPSS for Windows, version 20. Continuous variables were characterized by mean (± standard deviation) or median (minimum-maximum) if they had symmetric or asymmetric distribution, respectively, and categorical variables by absolute and relative frequencies. To compare continuous variables parametric tests (independent t test) or non-parametric tests (Mann Whitney-U test) were used. Chi-Square, Fisher's exact test or Monte Carlo's test were used to compare categorical variables. A multivariate analysis by logistic regression was performed to evaluate predictive factors of morbidity. A p value less than 0.05 was considered statistically significant.

This study was approved by the ethics commission (Comissão de Ética para a Saúde) of CHSJ.

3. Results

3.1. Demographic and clinical data (Tables 1 and 2)

During the study period, there were 40 neonates with gastroschisis admitted to the NICU, 20 male and 20 female. None of the patients had a family history of malformations. One newborn was transferred to another hospital on arrival and only evaluated at this unit during the first minutes of life.

Prenatal diagnosis was made in the majority of the cases (95%). Most births occurred in a tertiary centre (95%) and were done by caesarean section (92.5%). The mean gestational age was 35.85 (±1.777) weeks. The mean birth weight was 2422.25 (± 502.703) grams.

During hospitalization, 12 (30.8%) patients needed other surgeries. These included silo replacement, secondary closures, Ladd procedure, enterostomies and their reversals, enterectomies, adhesion lysis, enteroplasty, incisional hernia repair, inguinal hernia repair and ventriculoperitoneal shunt placement.

Compared with patients born with simple gastroschisis, those with complex gastroschisis had a significantly lower gestational age (mean 35 versus 36 weeks, p=0.039), higher incidence of major malformations (100% versus 15.2%, p=0.001), most of them gastrointestinal (60%), and needed more surgeries (80% versus 23.5%, p=0.017).

3.2. First hospitalization outcomes (Table 3)

Death occurred in 3 patients, who were all born with simple gastroschisis. All deaths occurred during the neonatal period and due to multiple organ failure: 1) The first patient was born at 37 weeks by caesarean section. He had an inflammatory "peel" and oedema of the intestinal loops, but there was no apparent atresia or perforation. He was submitted to a silo placement after almost 5 hours of life. In the first hours after surgery, there were bleeding through the silo base, hemodynamic instability, metabolic acidosis, hyponatremia and hyperkalaemia, anuria, anaemia and thrombocytopenia. At the 3rd day of life the patient was re-intervened. NEC was verified, which motivated a wide intestinal resection and duodenostomy. The patient died when arriving at the NICU after the surgery. 2) The second patient was diagnosed at 30 weeks of gestation and born at 32 weeks by caesarean section. Intestinal atresia was suspected and bladder, as well as bowel, was herniated. A primary closure was attempted, but due to high intra-abdominal pressure a silo placement was done. She developed acute kidney injury, persistent hyponatremia, metabolic acidosis and non-responsive hyperkalaemia which caused cardiac arrest, at day 3 of life. 3) The third patient was born at 39 weeks by emergent caesarean section in apparent death in another hospital. He suffered severe perinatal asphyxia which led to hypoxic-ischemic encephalopathy. He also developed metabolic acidosis. During transport he suffered hypotension and bradycardia. Primary closure was performed. The clinical course was complicated by status epilepticus, acute kidney injury and thrombocytopenia, with sudden cardiorespiratory arrest at day 16 of life.

Patients born with complex gastrosquisis stayed longer in the hospital (median 59 versus 23.5 days, p=0.009), had more days of TPN (50 versus 19 days, p=0.007) and reached total oral intake later (at 47 versus 22.5 days of life, p=0.036) than those with simple gastroschisis. Duration of mechanical ventilation showed no statistical difference between the groups. The duration of morphine analgesia was longer in the complex group (9 versus 3 days, p=0.034). There was a higher incidence of intestinal occlusion (60% versus 11.8%, p=0.032), bowel perforation (60% versus 0%, p=0.001) and bowel ischaemia (40% versus 0%, p=0.013) in the complex gastroschisis group. In this group, there was also a higher incidence of sepsis (100% versus 32.4%, p=0.008), cholestasis (60% versus 38.2%, p=0.631) and short bowel syndrome (40% versus 3.1%, p=0.042).

3.3. Follow-up during the first year of life (Table 4)

GERD was present in 12.5% of patients, all with simple gastroschisis. Laxative administration was needed by patients with complex gastroschisis (40%, p=0.022). When evaluating growth parameters, a bigger difference was seen at 6 months of life. In those born with complex gastroschisis, weight was significantly lower (median 6250 versus 6800 grams, p=0.048), with 75% of patients having a weight percentile under 5 (versus 13.6%) at 6 months, p=0.028.

3.4. Follow-up during the second and third years of life (Table 5)

Complex gastroschisis was found to greatly increase the risk of gastrointestinal symptoms during this two years (OR: 42; 95% CI: 2.01-877.5; p=0.016). Anthropometric variables were not significantly different between the groups and there were no infants below the 5th percentile for weight and length at 36 months.

During the 3-year follow-up, although not statistically significant, a higher percentage of patients with complex gastroschisis needed surgery for intestinal occlusion (50% versus 6.3%). Umbilical hernia repair was performed in 14.3% of the patients, all born with simple gastroschisis, and only one patient, born with complex gastroschisis, underwent intestinal lengthening surgery for short bowel syndrome.

3.5. Outcomes according to surgery type (Table 6)

Only statistically significant differences are shown. Mortality was higher in the secondary closure group (40% versus 2.9%). Start of oral intake and time to full enteral feeding occurred later in those who had secondary closure (median 25 versus 11.5 days, p=0.025, and 48 versus 23 days, p=0.041, respectively) and more patients of this group had NEC (40% versus 2.9%).

4. Discussion

The demographic and clinical data obtained showed a low socio-economic status (mostly parents' professions of a lower income or unemployment), a young maternal age, with most of the mothers being primigravidas, cigarette smoking during pregnancy in 20% of the mothers and complications in 25% of gestations, (intrauterine growth restriction in 40% of them). These data are in line with the literature.[1, 4]

Risk stratification of infants by categorizing their gastroschisis into simple and complex, as described by Molik et al and validated in other studies, provides a simple and readily available manner of predicting outcomes for the patients. Infants with complex gastroschisis have more complications, longer hospitalization and TPN periods and higher mortality rate.[6, 8-10]

The main factor affecting these patients' morbidity is the later onset of intestinal function. Therefore, a good way to evaluate outcome is by measuring the duration of TPN, start of oral intake and time to achieve total oral intake. Additionally, a longer TPN duration increases the risk of complications, such as central line sepsis and hepatic dysfunction.[6, 7]

In our study, patients with complex gastroschisis required more than double the days of hospitalization, TPN and morphine analgesia, as well as more than twice the time to achieve total oral intake when compared with those with simple gastroschisis. Although not statistically significant, start of oral intake and duration of mechanical ventilation were also worse for the complex group.

As predicted, there was a higher incidence of complications in the complex group, including intestinal occlusion, bowel perforation, bowel ischaemia and short bowel syndrome. Soares et al reported a higher incidence of sepsis in premature patients, who generally presented a more complex clinical picture and hence needed more elaborate surgical procedures.[5] In accordance, this study verified that the complex group not only had a higher incidence of sepsis, as expected due to the longer TPN, but also had a significantly lower gestational age at birth and needed more surgeries. This suggests that there may be a relationship between low gestational age and complex gastroschisis and a higher risk of developing sepsis.

The survival rate in this study was 92.3%, in line with the literature.[1, 4] Since there were only 3 deaths, surprisingly all in the simple gastroschisis group, no significant association was found between the type of gastroschisis and mortality.

During the first years of life, infants born with gastroschisis will often have nutritional issues. Some develop GERD or have symptoms reflecting hypomotility of their gastrointestinal tract. [4] In our study, follow-up during the first year of life revealed a higher consumption of laxatives in those born with complex gastroschisis when compared with those born with simple gastroschisis, despite the absence of a statistically significant difference in constipation prevalence, possibly due to the fact that its presence was only considered if symptoms lasted at least 3 months.

The results revealed that complex gastroschisis is a predictive factor for higher incidence of gastrointestinal symptoms after the first year of life. Consequently, it is recommended that patients with complex gastroschisis be followed until, at least, 3 years of life.

In a study about long term outcomes of gastroschisis, more than half the children required additional surgery besides abdominal wall closure. Surgery for intestinal obstruction due to adhesions was required in 24% of the cases, typically in the first year and in those with complex gastroschisis.[13] In our study, those with complex gastroschisis needed more surgeries during the first hospitalization than those with simple gastroschisis. Although not statistically significant, in this group there were also more patients that had intestinal occlusion surgery during the first 3 years of life. One patient with short bowel syndrome had intestinal lengthening surgery. Harris et al also report procedures to correct umbilical hernias and scars in gastroschisis patients.[13] There were no scar revisions in our study, possibly

because of the young age of our patients, in whom aesthetic concerns are not yet evident.[13] There were umbilical hernia repairs, all in the simple gastroschisis group.

Several studies show that although infants with gastroschisis have a growth delay during the first 2 or 3 years of life, the outcome is good in 75% of cases.[1, 2, 4] Many factors contribute to foetal growth restriction and early postnatal growth delay. A significant factor is thought to be bowel dysfunction, thus it is understandable that infants with complex gastroschisis have lower weights as they suffer from it for a longer period.[13] In our study, the complex gastroschisis group had lower median weight and more patients under the 5th percentile for weight at 6 months of life than the simple gastroschisis group. The same trend was verified for length, although not statistically significant. In total, the number of patients with weight and length under the 5^{th} percentile decreased progressively, from 23.1% and 32%, respectively, at 6 months of life to 0% for both at 36 months. A possible explanation for this progressive catch-up growth is the thrifty phenotype hypothesis (the organism adapts in response to the adverse intrauterine and postnatal environment). This would mean that these patients are at a higher risk of developing type 2 diabetes and obesity when they become older. [13] Long-term follow-up studies would be necessary to further explore this hypothesis.

Bradnock et al discuss the comparison between types of surgery as a way to predict the outcome of patients with gastroschisis. They concluded that very few studies found differences between the groups. Therefore, a multicentre randomised controlled trial that compares primary closure with a preformed silo approach in infants suitable for either type of treatment or that identifies factors contributing to the selection of the surgery type is needed to determine the optimal initial management strategy and define algorithms of care.[3, 6] As expected, our results showed no statistically significant differences for the majority of the variables evaluated in the first three years of life. Nevertheless, start of oral intake and time to full enteral feeding occurred later for those who had secondary closure, more patients of this group had NEC and there was a higher mortality rate (40%).

Soares et al also described a shorter time to achieve full enteral feeding in those who had primary closure, justified by the fact that these patients had simple gastroschisis and easier to correct complications.[5] However, in our study there was no statistical difference in the type of gastroschisis between those who had primary closure and those who had secondary closure. Another study demonstrated that, even in those with simple gastroschisis, if they are submitted to secondary closure there is more delay in starting oral intake and stopping mechanical ventilation, empiric antibiotic treatment and TPN, as well as a longer hospitalization, independently of patient characteristics.[3]

Most studies report a higher complication rate for those who had secondary closure, although one study by Martínez Criado et al found the opposite.[14] In our study, there was no statistically significant difference for the evaluated complications between the groups, except for NEC which was more prevalent in the secondary closure group.

There are some limitations of this retrospective study. Being an observational study, it is possible that there are confounding factors, such as individual patients' characteristics or factors influencing the surgical decision. It is from a single centre, meaning a small number of cases, as gastroschisis is a rare malformation. It is based on clinical records, which implies that there were some missing data, particularly concerning outpatient follow-up, and there may be some unknown and unmeasured factors that could have changed the results.

Despite these limitations, this study provides important information about the first three years of life of infants born with gastroschisis, which can be used to provide better parent counselling and improve patient management and care.

5. Conclusion

Risk stratification by type of gastroschisis was validated, showing that those with complex gastroschisis had worse outcomes during the first 3 years of life. Secondary closure was associated with higher

mortality and some morbidity indicators. Complex gastroschisis is a predictive factor for the development of gastrointestinal symptoms after the first year of life. Thus, follow-up of patients with complex gastroschisis is recommended at least during 3 years of life. Further research on outcomes is needed, especially with longer follow-up and evaluation of other outcomes (neurodevelopmental, vitamin or mineral deficiency, bone mass density). Multicentre randomised trials would help reach definitive conclusions and determine management strategies to improve gastroschisis patients' prognosis.

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Annexes

Table 1. Demographic and prenatal data according to gastroschisis type

	Total (n=40)	**Simple gastroschisis (n=34)**	**Complex gastroschisis (n=5)**	**p**
Maternal education, n (%)				
Basic Education	6 (54.5)	5 (71.4)	1 (25)	0.569*
Secondary education	1 (9.1)	0 (0)	1 (25)	
Higher education	4 (36.4)	2 (28.6)	2 (50)	
Maternal profession, n (%)				
1st and 2nd degree	6 (15.8)	3 (9.1)	3 (60)	0.999*
3rd degree	2 (5.3)	2 (6.1)	0 (0)	
4th and 5th degree	12 (31.6)	11 (33.3)	1 (20)	
Doesn't have / student / unemployed	18 (47.4)	17 (51.5)	1 (20)	
Paternal profession, n (%)				
1st and 2nd degree	4 (10.8)	2 (6.3)	2 (40)	0.406*
3rd degree	6 (16.2)	4 (12.5)	2 (40)	
4th and 5th degree	22 (59.5)	21 (65.6)	1 (20)	
Doesn't have / student / unemployed	5 (13.5)	5 (15.6)	0 (0)	
Maternal age (years), median (min-max)	22.5 (15-34)	22 (15-33)	25 (17-34)	0.474¥
Primigravida, n (%)	33 (86.8)	28 (87.5)	4 (80)	0.538§
Previous abortions, n (%)	4 (10.5)	3 (9.4)	1 (20)	0.456§
Smoking during pregnancy, n (%)	4 (20)	3 (18.8)	1 (25)	0.999§
Drugs during pregnancy, n (%)	10 (25.6)	9 (27.3)	1 (20)	0.999§
Corticosteroids	5 (50)	4 (44.4)	1 (100)	0.897*
Antibiotics	1 (10)	1 (11.1)	0 (0)	
Corticosteroids and antibiotics	3 (30)	3 (33.3)	0 (0)	
Antiretroviral drugs	1 (10)	1 (11.1)	0 (0)	
Gestation complications, n (%)	10 (25)	8 (23.5)	2 (40)	0.587§
Oligohydramnios	2 (20)	1 (12.5)	1 (50)	0.387§
Intrauterine growth restriction	4 (40)	4 (50)	0 (0)	0.467§
Diagnosis, n (%)				
At birth	2 (5)	1 (2.9)	1 (20)	0.243§
Prenatal	38 (95)	33 (97.1)	4 (80)	
Gestational week, median (min-max)	21 (12-36)	20.5 (12-36)	22 (21-31)	0.385¥

*Monte Carlo's test, §Fisher's exact test, ¥Mann-Whitney U test

Table 2. Clinical data according to gastroschisis type

	Total (n=40)	Simple gastroschisis (n=34)	Complex gastroschisis (n=5)	p
Gestational age (weeks), median (min-max)	36 (32-39)	36 (32-39)	35 (32-36)	**0.039¥**
Birth place, n (%)				
Tertiary centre	38 (95)	33 (97.1)	4 (80)	0.243§
Other hospitals	2 (5)	1 (2.9)	1 (20)	
Gender, n (%)				
Male	20 (50)	17 (50)	3 (60)	0.999§
Female	20 (50)	17 (50)	2 (40)	
Birth weight (grams), median (min-max)	2445 (1500-3575)	2445 (1500-3575)	2170 (1580-2610)	0.180ᵐ
Delivery, n (%)				
Vaginal	3 (7.5)	2 (5.9)	1 (20)	0.345§
Caesarean section	37 (92.5)	32 (94.1)	4 (80)	
Reanimation at birth, n (%)	12 (30)	9 (26.5)	3 (60)	0.159§
Meconium aspiration, n (%)	6 (15)	5 (14.7)	1 (20)	0.999§
Apgar Score at 1st minute <7, n (%)	8 (20)	7 (20.6)	1 (20)	0.999§
Apgar Score at 5th minute <7, n (%)	2 (5)	1 (2.9)	1 (20)	0.243§
Major malformations, n (%)	10 (26.3)	5 (15.2)	5 (100)	**0.001§**
Gastrointestinal atresia	1 (9.1)	0 (0)	1 (20)	0.455§
Enteric duplication cyst	1 (9.1)	0 (0)	1 (20)	0.455§
Microcolon	1 (9.1)	0 (0)	1 (20)	0.455§
Cryptorchidism	2 (18.2)	0 (0)	2 (40)	0.182§
Cardiac malformations	4 (36.4)	4 (66.7)	0 (0)	0.061§
Minor anomalies, n (%)	26 (68.4)	21 (63.6)	5 (100)	0.158§
Chromosome anomalies, n (%)	3 (11.1)	2 (8.4)	1 (33.3)	0.308§
Herniated organs, n (%)				
Liver	2 (5.3)	1 (3)	1 (20)	0.249§
Bladder and/or gonads	10 (26.3)	10 (30.3)	0 (0)	0.298§
Time to surgery (minutes), median (min-max)	90 (0-394)	98 (0-394)	68 (0-193)	0.276¥
Type of surgery, n (%)				
Primary closure	34 (87.2)	30 (88.2)	4 (80)	0.517§
Secondary closure (silo)	5 (12.8)	4 (11.8)	1 (20)	
Time with silo (days), median (min-max)	4 (3-20)	7.5 (3-20)	4 (4)	0.999¥
Other surgeries, n (%)	12 (30.8)	8 (23.5)	4 (80)	**0.017§**

¥Mann-Whitney U test, §Fisher's exact test, ᵐIndependent t test

Table 3. Outcome according to gastroschisis type

	Total (n=40)	**Simple gastroschisis (n=34)**	**Complex gastroschisis (n=5)**	**p**
Hospital stay (days), median (min-max)	24 (3-788)	23.5 (3-166)	59 (24-788)	**0.009¥**
Total parenteral nutrition (days), median (min-max)	21 (0-787)	19 (0-156)	50 (22-787)	**0.007¥**
Start of oral intake (days of life), median (min-max)	12 (5-47)	12 (5-47)	22 (10-45)	0.395¥
Total oral intake reached (days of life), median (min-max)	23 (8-156)	22.5 (8-156)	47 (23-65)	**0.036¥**
Mechanical ventilation (days), median (min-max)	4 (0-41)	4 (0-41)	9 (1-14)	0.164¥
Analgesia and sedation, n (%)				
Morphine	37 (94.9)	33 (97.1)	4 (80)	0.999§
Days, median (min-max)	4 (1-34)	3 (1-34)	9 (6-15)	**0.034¥**
Paracetamol	28 (71.8)	25 (73.5)	3 (60)	0.999§
Days, median (min-max)	4 (1-10)	4 (1-10)	4 (2-6)	0.889¥
Midazolam	20 (51.3)	17 (50)	3 (60)	0.999§
Days, median (min-max)	3 (1-33)	3 (1-33)	8 (2-14)	0.258¥
Wound dehiscence, n (%)	1 (2.6)	1 (3)	0 (0)	0.999§
Intestinal occlusion, n (%)	7 (17.9)	4 (11.8)	3 (60)	**0.032§**
Bowel perforation, n (%)	3 (7.7)	0 (0)	3 (60)	**0.001§**
Bowel ischaemia, n (%)	2 (5.1)	0 (0)	2 (40)	**0.013§**
Necrotizing enterocolitis, n (%)	3 (7.7)	2 (5.9)	1 (20)	0.345§
Sepsis, n (%)	16 (41)	11 (32.4)	5 (100)	**0.008§**
Cholestasis, n (%)	16 (41)	13 (38.2)	3 (60)	0.631§
Multiple organ failure, n (%)	4 (10.3)	4 (11.8)	0 (0)	0.999§
Short bowel syndrome, n (%)	3 (8.1)	1 (3.1)	2 (40)	**0.042§**
Discharge with parenteral nutrition, n (%)	2 (5.6)	1 (3.2)	1 (20)	0.262§
Death, n (%)	3 (7.7)	3 (8.8)	0 (0)	0.999§
Cause of death				
Multiple organ failure	3 (100)	3 (100)	0 (0)	0.999§
Age (days), median (min-max)	3 (3-16)	3 (3-16)	-	-

¥Mann-Whitney U test, §Fisher's exact test

Table 4. 1-year follow-up according to gastroschisis type

	Total (n=40)	**Simple gastroschisis (n=34)**	**Complex gastroschisis (n=5)**	**p**
GERD, n (%)	4 (12.5)	4 (14.8)	0 (0)	0.999 §
Intestinal subocclusion, n (%)	2 (6.5)	1 (3.8)	1 (20)	0.301 §
Comorbidities, n (%)	9 (29)	7 (26.9)	2 (40)	0.613 §
Gastrointestinal symptoms, n (%)	3 (9.4)	2 (7.4)	1 (20)	0.410 §
Vomiting, n (%)	1 (3.1)	1 (3.7)	0 (0)	0.999 §
Constipation, n (%)	2 (6.2)	1 (3.8)	1 (20)	0.301 §
Medication, n (%)	9 (29)	7 (26.9)	2 (40)	0.613 §
Prokinetics, n (%)	7 (22.6)	7 (26.9)	0 (0)	0.562 §
Laxatives, n (%)	2 (6.5)	0 (0)	2 (40)	**0.022 §**
Antacids, n (%)	2 (6.5)	2 (7.7)	0 (0)	0.999 §
Weight percentile 6M <P5, n (%)	6 (23.1)	3 (13.6)	3 (75)	**0.028§**
Weight percentile 12M <P5, n (%)	4 (16.7)	3 (15)	1 (25)	0.544§
Length percentile 6M <P5, n (%)	8 (32)	5 (23.8)	3 (75)	0.081§
Length percentile 12M <P5, n (%)	4 (16.7)	2 (10)	2 (50)	0.115§

§Fisher's exact test, *Monte Carlo's test, ¥Mann-Whitney U test

GERD: gastro-oesophageal reflux disease.

Table 5. 3-year follow-up according to gastroschisis type

	Total (n=40)	**Simple gastroschisis (n=34)**	**Complex gastroschisis (n=5)**	**p**
Intestinal subocclusion, n (%)	1 (5.3)	0 (0)	1 (25)	0.211§
Comorbidities, n (%)	13 (59.1)	10 (55.6)	3 (75)	0.616§
Gastrointestinal symptoms, n (%)	4 (21.1)	1 (6.7)	3 (75)	**0.016§**
Diarrhoea	1 (5.3)	0 (0)	1 (25)	0.211§
Constipation	3 (15.8)	1 (6.7)	2 (50)	0.097§
Medication (laxatives), n (%)	4 (21.1)	2 (13.3)	2 (50)	0.178§
Surgeries, n (%)	6 (28.6)	4 (23.5)	2 (50)	0.544§
Umbilical hernia surgery, n (%)	3 (14.3)	3 (17.6)	0 (0)	0.999§
Age (months), median (min-max)	7 (2-36)	7 (2-36)	-	-
Intestinal occlusion surgery, n (%)	3 (15)	1 (6.3)	2 (50)	0.088§
Age (months), median (min-max)	4 (1.5-34.5)	1.5 (-)	19.25 (4-34.5)	0.999¥
Intestinal Lengthening surgery, n (%)	1 (5)	0 (0)	1 (25)	0.200§
Age (months), median (min-max)	34	-	34 (-)	-
Weight percentile 24M <P5, n (%)	1 (5.6)	1 (7.1)	0 (0)	0.999§
Weight percentile 36M <P5, n (%)	0 (0)	0 (0)	0 (0)	-
Length percentile 24M <P5, n (%)	0 (0)	0 (0)	0 (0)	-
Length percentile 36M <P5, n (%)	0 (0)	0 (0)	0 (0)	-

§Fisher's exact test, *Monte Carlo's test, ¥Mann-Whitney U test

Table 6. Clinical data according to the type of surgery

	Total (n=40)	Primary closure (n=34)	Secondary closure (n=5)	p
Start of oral intake (days), median (min-max)	12 (5-47)	11.5 (5-45)	25 (22-47)	**0.025**[¥]
Total oral intake reached (days), median (min-max)	23 (8-156)	23 (8-156)	48 (31-53)	**0.041**[¥]
Necrotizing enterocolitis, n (%)	3 (7.7)	1 (2.9)	2 (40)	**0.038**[§]
Death, n (%)	3 (7.7)	1 (2.9)	2 (40)	**0.038**[§]

[¥]Mann-Whitney U test, [§]Fisher's exact test

O meu muito obrigada a todos que contribuíram para a realização desta tese:

À Dra. Susana Pissarra e ao Professor Doutor Tiago Henriques-Coelho pela orientação, contribuições valiosas ao longo de todas as etapas deste projeto, desde a sua conceção à comunicação dos resultados, e palavras de encorajamento, que constituíram um apoio para o meu desenvolvimento na área da investigação.

À Professora Doutora Hercília Guimarães pela oportunidade que me deu de realizar este trabalho integrada na sua equipa de investigação, pela disponibilidade manifesta na leitura atenta das várias versões, pelos seus pertinentes comentários e apreciações críticas que foram um estímulo para prosseguir e atingir esta meta importante da minha vida académica e profissional.

À Dra. Filipa Flor de Lima pelo seu indispensável contributo na análise estatística e pelos seus bons conselhos.

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Ao Renato pela disposição incondicional para discutir assuntos científicos e clínicos relacionados com este trabalho e pelo afeto e palavras doces em momentos de desânimo.

Aos meus pais que me transmitiram os seus valores, apesar de estarem longe me acompanham atentamente com amor e ternura e me oferecem espaço para crescer em liberdade, responsabilidade e respeito pela dignidade humana.

A todos outros, meus familiares e amigos, pela amizade e solidariedade que tornaram este percurso mais agradável.

FACULDADE DE MEDICINA
UNIVERSIDADE DO PORTO

Anexos:

1. **Parecer da Comissão de Ética para a Saúde do Centro Hospitalar São João**
2. **Normas de submissão da revista**

março, 2015

Direcção Clínica
10/3/15

CES 268-14

AUTORIZADO
CONSELHO DE ADMINISTRAÇÃO REUNIÃO DE 20 MAR 2015
Presidente do Conselho de Administração
(Prof. Doutor António Ferreira)
Directora Clínica | Enfermeira Directora | Vogal Executivo | Vogal Executivo
(Dra. Margarida Tavares) | (Enfermeira Eurídice Portela) | (Dr. João Oliveira) | (Dr. Amaro Ferreira)

Exmo. Senhor

Presidente da Comissão de Ética para a Saúde do Centro Hospitalar de S. João – EPE

Assunto: Pedido de apreciação e parecer para estudo/projecto de investigação

Nome do Investigador Principal: Lília Patrícia de Mendonça Valente

Título do projecto de investigação: Gastroschisis: factors influencing 3-year survival and digestive outcome

Pretendendo realizar no(s) Serviço(s) de Neonatologia do Centro Hospitalar de S. João – EPE o estudo/projecto de investigação em epígrafe, solicito a V. Exa., na qualidade de Investigador/Promotor, a sua apreciação e a elaboração do respectivo parecer.

Para o efeito, anexo toda a documentação referida no dossier dessa Comissão respeitante a estudos/projectos de investigação.

Com os melhores cumprimentos.

Porto, 10 / novembro / 2014

COMISSÃO DE ÉTICA
11/11/14
RECEPÇÃO DE DOCUMENTOS

O INVESTIGADOR/PROMOTOR

Lília Valente

7. SEGURO

a. *Este estudo/projecto de investigação prevê intervenção clínica que implique a existência de um seguro para os participantes?*

SIM ☐ (Se sim, junte, por favor, cópia da Apólice de Seguro respectiva)
NÃO ☐
NÃO APLICÁVEL ☑

8. TERMO DE RESPONSABILIDADE

Eu, Lília Patrícia de Mendonça Valente,
abaixo-assinado, na qualidade de Investigador Principal, declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (com as emendas de Tóquio 1975, Veneza 1983, Hong-Kong 1989, Somerset West 1996 e Edimburgo 2000) e da Organização Mundial da Saúde, no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo no decurso do actual internamento ou da mesma consulta.

Porto, 10 / novembro / 2014

A Comissão de Ética para a Saúde tendo aprovado o parecer do Relator, aguarda que o Investigador/Promotor esclareça as questões nele enunciadas para que possa ser definitivo.
Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética
2014.12.03

Lília Valente
O Investigador Principal

PARECER DA COMISSÃO DE ÉTICA PARA A SAÚDE DO CENTRO HOSPITALAR DE S. JOÃO

emitido na reunião plenária da CES de / /

Considerado que foram cumpridos os esclarecimentos prestados pela investigadora

A Comissão de Ética para a Saúde APROVA por unanimidade o parecer do Relator, pelo que nada tem a opor à realização deste projecto de investigação.

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética
2015.02.02

Anexo 2.

Journal of Pediatric and Neonatal Individualized Medicine (JPNIM)

Author Guidelines

The Papers must be written in English or Italian and must be **original** (not published elsewhere in whole or in part).

Text

Please submit the text in a Word file.

Papers length should be generally around **20,000** characters.

All acronyms in the text should be expanded at first mention, followed by the abbreviation in parentheses.

Please use the following font: Times New Roman, 11 pt.

For paragraph formatting, please use single spacing and full justification.

Do not use boldface or underline character formatting; use italics just for technical terms or not English words. Use quotation marks just for quotations or to underline a particular word meaning.

Do not insert footnotes. Divide the text in **paragraphs** and assign a title to each part.

Abstract and keywords

For every article, authors should send:

- an abstract of **250-300 words**, and
- **6** keywords.

Abstract and keywords must be in English also for Italian articles.

Figures and tables

Figures (graphs, charts, photographs, and illustrations) and tables should be submitted separately from the text file:

- **for graphs and charts**, use Excel files;
- **for photographs and illustrations**, use JPEG, PNG or TIFF files (or, at least, PowerPoint);
- **for tables**, use Excel or Word files.

Please only use the following **fonts** in figures: **Helvetica or Arial**.

Authors should quote figures and tables in the text and should number them in the order in which they appear in the text. Each figure and table should be accompanied by a **short description**.

Figures and tables must be **original**.

Please note that editors and the publisher could evaluate the sent files overall and decide to modify the number of figures and tables.

Videos, audios and 3D illustrations

Starting from July 2014, we intend to accept also 3D illustrations, audios and videos (e.g., with slide presentations or demonstrations of clinical procedures) to integrate (as PDF-embedded multimedia) into each kind of article, and we are planning to start a new *Video* series, featuring the explanation of medical procedures. You are welcome to send your contributions for evaluation (see more here).

If you plan to send a video, please make sure to follow these guidelines:

- **file format: .mp4 (H.264 encoded)**;
- dimensions: 645x360 or smaller.

Videos, audios and 3D illustrations must be **original**.

References

Please list the references **in order of citation** in the text, in **square brackets**.

For each entry, please clearly indicate the following data: names of **all the authors**, title of the article/book, publication year. Moreover, for journal articles, indicate journal title, volume, issue, first and last page of the article; for websites, indicate the last access; for books, indicate the book publisher and its head office. If you want to quote a chapter within a book, please add information on the chapter (title and authors). Examples:

- **article (see and follow Pub Med citations)**: Mishra J, Dent C, Tarabishi R, Mitsnefes MM, Ma Q, Kelly C, Ruff SM, Zahedi K, Shao M, Bean J, Mori K, Barasch J, Devarajan P. Neutrophil gelatinase-associated lipocalin (NGAL) as a biomarker for acute renal injury after cardiac surgery. Lancet. 2005;365(9466):1231-8.
- **book**: Cowan CP, Cowan PA. When partners become parents: the big life change for couples. New York: Basic Books, 1992.
- **chapter within a book**: Eyben E. Fathers and sons. In: Rawson B (Ed.). Marriage, divorce and children in ancient Rome. Oxford: Clarendon Press, 1991.
- **website**: http://guidance.nice.org.uk/CG54, last access: April 2012.

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